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U. S NAVAL TECHNICAL MISSION TO JAPAN
CARE OF FLEET POST OFFICE
SAN FRANCISCO, CALIFORNIA

13 February 1946

RESTRICTED

From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.

Subject: Target Report - Japanese Electronics, Miscellaneous.

Reference: (a)"Intelligence Targets Japan" (DNI) of 4 Sept. 1945.

1. Subject report, covering Target E-30(N) of Fascicle E-1 of reference (a), is submitted herewith.

2. The investigation of the target and the target report were accomplished by Comdr. M. C. Mains, USN(Ret.), assisted by Lieut. P. D. Lacy, USNR, Lt.(jg) J. R. Dannemiller, USNR, and Lt.(jg) E. L. Snow, USNR, who also acted as interpreter and translator.

C. G. Grimes

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Captain, USN

30621

RESTRICTED

E-30(N)

JAPANESE ELECTRONICS, MISCELLANEOUS

"INTELLIGENCE TARGETS JAPAN" (DNI) OF 4 SEPT. 1945

FASCICLE E-1, TARGET E-30(N)

FEBRUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ELECTRONICS TARGETS

JAPANESE ELECTRONICS, MISCELLANEOUS

The information contained in this report, which supplements previous reports on electronics subjects,* was obtained chiefly from three sources: (1) The Second Naval Technical Institute at KANAZAWA, YOKOHAMA, and TOKYO; (2) The Fukuoka Laboratory of the International Telecommunications Company; and (3) Tokyo Shibaura Electric Company, KAWASAKI.

Samples of Japanese equipments, in addition to those listed in NavTechJap Report, "Japanese Electronics - General," Index No. E-28, were obtained and forwarded to the Naval Research Laboratory.

A plane goniometer, Yagi antenna, wide-band antenna and an impedance bridge developed by the Fukuoka Laboratory of the International Telecommunication Company are described in the report. Information also is included on types of glasses used by the Japanese in tube production and for radio-frequency insulation.

A boraxless-glass and a two percent borax glass had been developed in an effort to conserve the supply of boron, which was very low.

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*See NavTechJap Reports, Index Nos. E-01 to E-29.

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LIST OF ENCLOSURES

LIST OF ILLUSTRATIONS

REFERENCES

Location of Target:

Second Naval Technical Institute, KANAZAWA, TOKOHAMA, and TOKYO.

Fukuoka Laboratory of International Telecommunication Co., Ltd. (Kokusai Denki Tsushin Kaisha), at FUKUOKA Mura, Iruma Gun, Saitama Ken.

Tokyo Shibaura Electric Company, KAWASAKI.

Japanese Personnel Who Assisted in Gathering Documents and Material:

Capt. I. ARISKA, Second Naval Technical Institute.

T. ABE, D.Sc., Glass Engineering Department, Tokyo Shibaura Electric Company.

Japanese Personnel Interviewed:

Capt. I. ARISAKA, Second Naval Technical Institute.

Dr. S. NAMBA, Director, International Telecommunication Company.

Mr. H. TAKEUCHI, former head of antenna research, Fukuoka Laboratory International Telecommunication Company.

T. ABE, D.Sc., Tokyo Shibaura Electric Company.

S. KOMAGATA, Ph.D., Electric Chemical Laboratory, Gotanda, TOKYO.

Reports of Other Agencies:

Technical Liaison and Investigation Department, Office of Chief Signal Officer, SCAP, report on "Radio Equipment for Japanese Bombing Balloons," 2 February 1946.

Final report of technical Liaison and Investigation Department, SCAP.

INTRODUCTION

Target E-30(N) was established as a repository for miscellaneous information on electronics subjects which might be uncovered after completion of the reports on the other electronics targets. It was believed that the subject of electronics had been thoroughly covered without bringing to light anything really outstanding; therefore, it was not considered justifiable to delay submission of the other reports.

A few leads were received which appeared to have some promise, and after a check was made for coverage by previous reports of this Mission and other agencies, they were investigated.

THE REPORT

A. JAPANESE AIRBORNE RADAR, SUPPLEMENT*

Included in the airborne radio and radar equipment obtained at the Kanazawa Laboratory of the Second Naval Technical Institute were two experimental radar equipments:

1. Experimental 19 Air Mark 1 Model 12 (FK-3). Items of this equipment forwarded to the Naval Research Laboratory, with their identifying numbers, are listed in Enclosure (A).

2. Type 3 Air Mark 6 Model 3 (H-6). With the exception of the receiver, this equipment was found to be identical with older models of the Mark 6 which are described in the basic NavTechJap report on Japanese airborne radar.* Therefore only the receiver has been forwarded to the Naval Research Laboratory. See Enclosure (A).

B. JAPANESE RADIO AND RADAR DIRECTION FINDERS, SUPPLEMENT**

1. Plane Goniometer. A plane goniometer developed by the Fukuoka Laboratory of the International Telecommunications Co. is shown in Figure 1. It was used in experimental direction finders developed by the Second Naval Technical Institute.

In Figure 1, stator terminals are 1 and 1' and the rotar terminals are 0 and 0'. At the position shown in the plan view in Figure 1, the coupling coefficient is at its maximum positive value. The form of the rotor is made such that $f(\alpha) = R\sqrt{\sin\alpha}$ where R is the maximum radius of the rotor.

2. Airborne Direction Finders. Airborne radio and radar equipments obtained at the Kanazawa Laboratory of the Second Naval Technical Institute and shipped to the Naval Research Laboratory are listed in Enclosure (A). One of the equipments listed, the Experimental 19 (FP), appeared to have no unusual merit but was forwarded as being the latest development of its kind in Japan.

C. JAPANESE RADIO EQUIPMENT, SUPPLEMENT***

1. Noise Suppressor. The noise suppressor circuit shown in Figure 2 was developed at the Fukuoka Laboratory of the International Telecommunication Co. In the figure, the first 6H6 is the second detector and the second 6H6 is the noise limiter. There appears to be nothing new or remarkable about this circuit, and it is included only as a matter of general interest.

2. Airborne Radio Equipment. A considerable quantity of airborne radio equipment was found at the Kanazawa, Yokohama Laboratory of the Second Naval Technical Institute. As this material was of the latest type developed and largely in the experimental category, it was deemed advisable to ship samples to the Naval Research Laboratory for study. Equipment shipped is listed in Enclosure (A).

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*See NavTechJap Report, "Japanese Airborne Radar," Index No. E-02.
**See NavTechJap Report, "Japanese Radio and Radar Direction Finders," Index No. E-05.
***See NavTechJap Report, "Japanese Radio Equipment," Index No. E-08.

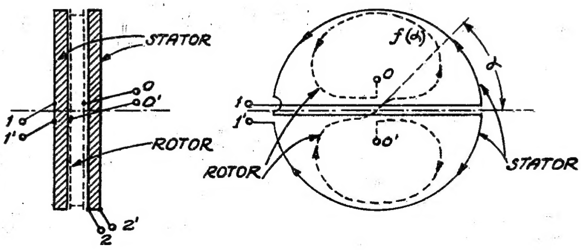

Figure 1
PLANE GONIOMETER

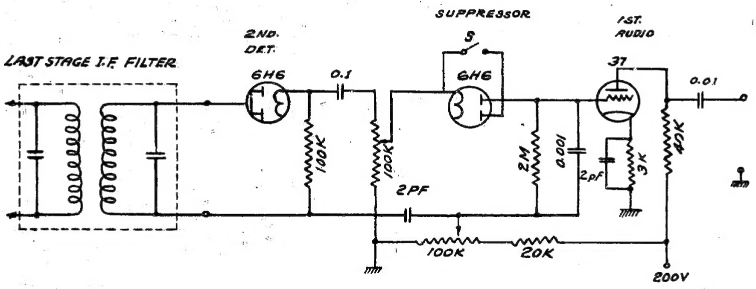

Figure 2
NOISE SUPPRESSOR

In addition to several types of airborne communications transceivers, the shipment included two portable radio equipments, designed to be used by parachute troops. One of them, the Experimental 18 Mark 8 Model 2, is a transmitter-receiver-dynamotor combination; the other, Experimental 18 Air Mark 8 Model 3, consists of a very compact transceiver and a battery box. No equipment of this type had been discovered previously.

3. Radio Transmitter for Bombing Balloons. A report of the Technical Liaison and Investigation Department, G-2, SCAP, dated 2 February 1946, describes the transmitters used to transmit weather information from the Japanese bombing ballons. The standard model had an initial power of 5 watts when the batteries were new, and a power of 1.5 watts after 20 hours of continuous operation. The transmitter operated in three frequency bands, 5 mc, 9 mc, and 16 mc. Band-switching was automatic. A multi-vibrator was used for modulation, and the transmitter was so highly overmodulate that it amounted to pulse transmittion. Pressure information was transmitted by varying the carrier frequency, temperature information by change of modulation frequency. For further details and a circuit diagram, reference should be made to the TLID report mentioned above.

D. JAPANESE NAVIGATIONAL AIDS, SUPPLEMENT*

Several complete sets of the Temporarily Designated Model 1 (FH-1) radio altimeter were found at KANAZAWA. Three equipments have been shipped to the Naval Research Laboratory. See Enclosure (A).

E. JAPANESE ANTENNAE, SUPPLEMENT**

1. Yagi Antenna. A Yagi antenna of one radiator, one reflector and three projector elements was developed by the Fukuoka Laboratory of the International Telecommunications Co. for use in ultra-short-wave radiotelephone transmission. Figure 3 shows the dimensions and spacing, Figure 4 shows directivity. Gain is about 8 to 10 db.

2. Wide-Band Antenna. It appears that little thought was given by the Japanese to the problem of wide-band antennae. However, the Fukuoka Laboratory of the International Telecommunications Co. experimented with two types for television use. Figure 5 shows the dimensions of the double fan type, Figure 6 shows the directivity, and Figure 7 shows the variation of input impedance with frequency.

In Figure 8 are shown a 7-branch and a 13-branch fishbone antenna. Impedance and directivity characteristics are shown in Figure 9 and 10, respectively.

F. JAPANESE RADIO FREQUENCY MEASURING TECHNIQUES, SUPPLEMENT***

1. Impedance Bridge. The circuit of this instrument, developed at the Fukuoka Laboratory of the International Telecommunications Co., is shown in Figure 11.

The unknown impedance is connected across XX', and G, C_1, and C_2 are adjusted to make $I_1 = I_2$. The unknown impedance may also be connected across XE or X'E.

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*See NavTechJap Report, "Japanese Navigational Aids," Index No. E-09.
**See NavTechJap Report, "Japanese Antennae," Index No. E-16.
***See NavTechJap Report, "Japanese Radio Frequency Measuring Techniques," ***Index No. E-22.

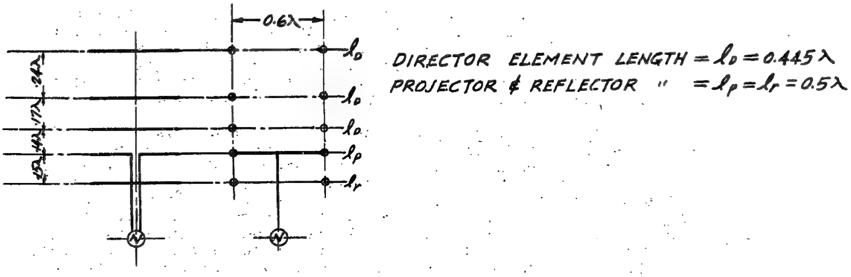


Figure 3
YAGI ANTENNA DIMENSIONS

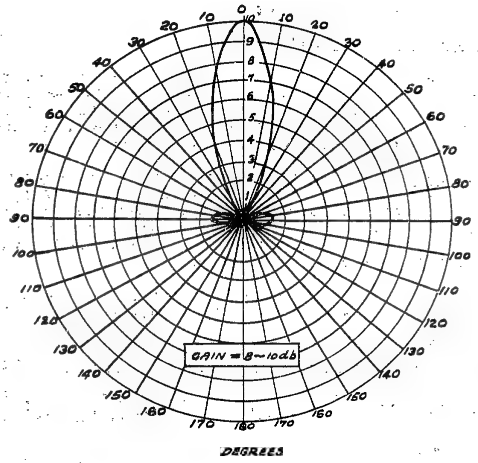
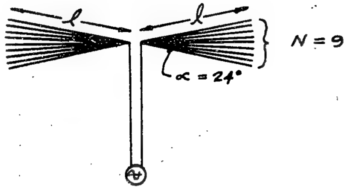


Figure 4
DIRECTIVITY OF YAGI ANTENNA



$\ell = 0.36 \sim 0.50\,\lambda$

Figure 5
CONSTRUCTION OF DOUBLE FAN ANTENNA

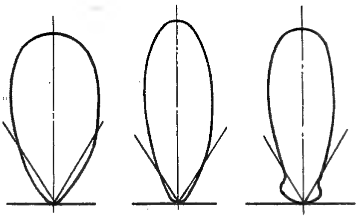


Figure 6
DIRECTIVITY OF DOUBLE FAN ANTENNA

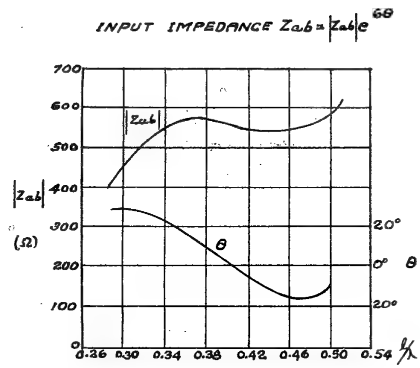


Figure 7

IMPEDANCE OF DOUBLE FAN ANTENNA

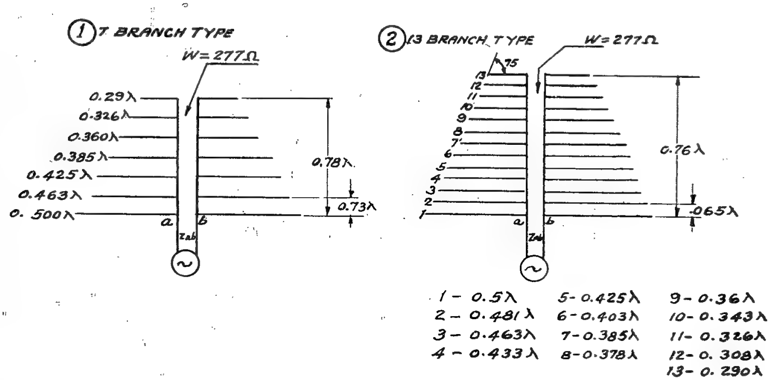


Figure 8

DIMENSIONS OF FISHBONE ANTENNAE

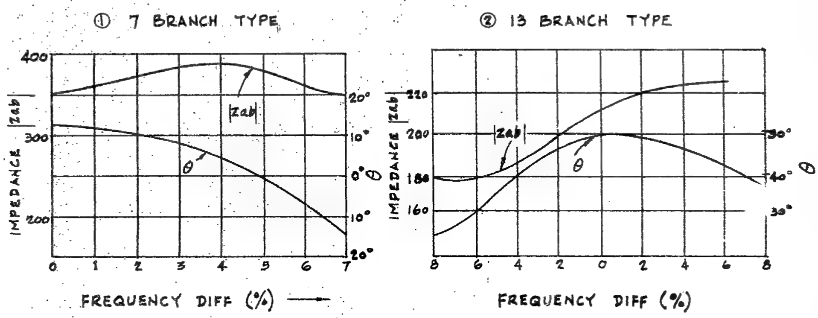


Figure 9

IMPEDANCE OF FISHBONE ANTENNAE

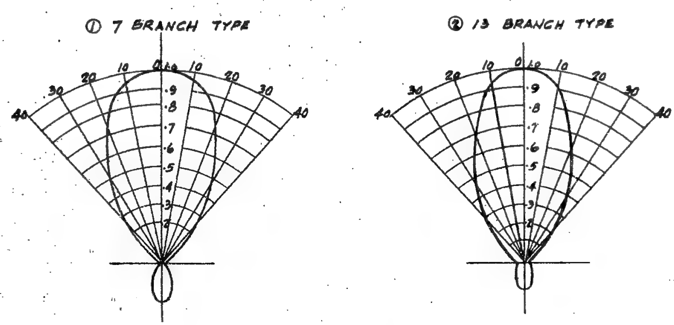


Figure 10

DIRECTIVITY OF FISHBONE ANTENNAE

The relations between unknown values and observed values of G, C_1 and C_2 are shown in Table I.

The range of measurement of capacity is 0 to 500 micromicrofarads, and of resistance, 10 to 100,000 ohms.

Figure 12 shows the results of test measurements made on a 600-ohm parallel feeder line.

G. JAPANESE INSULATION MATERIALS, SUPPLEMENT*

Table II lists the types of glasses used by the Japanese in tube production and for radio-frequency insulation. A departure from standard composition is to be found in the non-boric-oxide hard glass (TNB-28 and NB-18). This glass was developed so that the requirements of the glass industry for boron could be minimized; the supply of boron was very low. This glass, however, never reached the stage of full practicability.

The major portion of the development work on boraxless glass was done by S. KOMAGATA of the Electro-Chemical Laboratory. At the end of the war, this glass had not been developed sufficiently to be practical for tube production. The shrinkage was 75% when using boraxless glass compared to usual hard borosilicate glass. The normal shrinkage loss is three out of four in manufacture, and one out of two in shipping. The boraxless glass retained strains after blowing and cooling which accounted for the greater shrinkage.

A 2% borax content glass was developed for use in stem construction. The temperature coefficient of this glass adequately matches that of the lead-thru wires.

The composition of the two above-mentioned glasses are:

	Boraxless	2% Borax
SiO_2	70-72%	72-73%
$Al_2O_3 + Fe_2O_3$	5-6	1.5-2.5
Na_2O	4.5-5.5	4.5-5.5
K_2O	0.5-1.8	
PbO	3.0-5.0	11-12
ZnO	8.0-9.0	
MgO	4.0-5.0	6-7
F_2	0.1-0.2	
B_2O_3		2-3

A method for carrying stem leads thru the glass, which would avoid the necessity of matching temperature coefficients and allow use of non-critical metals, was under development at the Tokyo Shibaura Electric Company. This method consists of sheathing a pure iron wire of small diameter with a thin copper sleeve of about 0.08mm thickness, then welding the sheath to the iron wire at one end. Using this lead-in wire, the ductility of the copper and free space between sheath and inner wire allows easy expansion or contraction of the

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*See NavTechJap Report, "Japanese Insulation Materials," Index No. E-23.

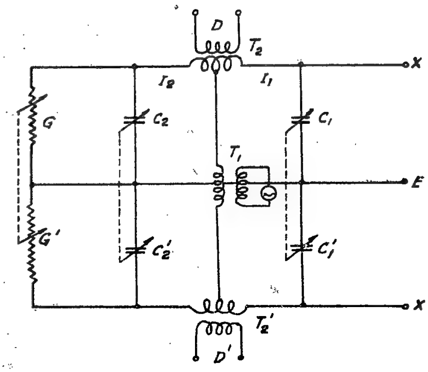


Figure 11
IMPEDANCE BRIDGE, SCHEMATIC

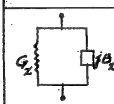
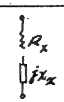
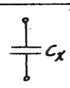
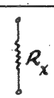
	UNKNOWN VALUE		MEASURED VALUE X X'	MEASURED VALUE X E
	$Y_x = G_x + jB_x$	G_x	$\frac{G}{2}$	G
		B_x	$\frac{1}{2}\omega(C_2 - C_1)$	$\omega(C_2 - C_1)$
	$Z_x = R_x + jX_x$	R_x	$\frac{2G}{G^2+\omega^2(C_2-C_1)^2}$	$\frac{G}{G^2+\omega^2(C_2-C_1)^2}$
		X_x	$\frac{-2\omega(C_2-C_1)}{G^2+\omega^2(C_2-C_1)^2}$	$\frac{-\omega(C_2-C_1)}{G^2+\omega^2(C_2-C_1)^2}$
	$j\omega C_x$	C_x	$\frac{1}{2}(C_2 - C_1)$	$(C_2 - C_1)$
	$j\omega L_x$	L_x	$\frac{-2}{\omega^2(C_2-C_1)}$	$\frac{-1}{\omega^2(C_2-C_1)}$
	R_x	R_x	$\frac{2}{G}$	$\frac{1}{G}$

TABLE I

IMPEDANCE BRIDGE - UNKNOWN VS. KNOWN VALUES

glass without damage. The application of this to tube production had not been effected at the end of the war. However, work is slowly continuing on this process.

TABLE II

JAPANESE TUBE AND RADIO FREQUENCY INSULATION GLASSES

Maker	Number[2]	Composition	Hardness	Main Use[3]	Sealing	Thermal Expansion $\alpha \cdot 10^7$ 100° to 300°C	Power Factor tan δ · 10^{-4} 10mc	Power Factor tan δ · 10^{-4} 600mc	Machine or Hand Blowing
T	IM-2	Soda lime magnesia	Soft	BRT		102	60	69	Machine
T	IM-2S	Soda lime magnesia	Soft	BRT		109			Hand
T	RG-3	Potash soda lime	Soft	BPHT		104			Hand
T	R-32	Potash lead	Soft	SRT	Dumet	92	10	22	Machine
T	B-814	Potash lead	Soft	SRCT		92			Machine
T	CP-34	Lead boro-silicate	Hard	BSTT	Tungsten	34	17	29	Hand
T	NB-18	Non boric acid	Hard	BTT		50	60		Hand
T	FNC-42	Boro-silicate	Hard	EMT	Fernico	44			Hand
T	Terex	Boro-silicate	Hard	INS		36	32	45*	Press Machine
S	BOC-16	Lead boro-silciate	Hard	BSTT	Tungsten	39			
S	LF-8	Lead	Soft	SRT	Dumet	94 ± 2			
S	BS-3	Soda lime lead	Soft	BRT		100 ± 3			
S	LBC-5	2.5% boric oxide	Hard	BTT		53			
N	B-7	Boro-silicate	Hard	BSTT	Molybdenum	51			
N	DP-7	Lead barium	Soft	BSRT	Dumet	94 ± 2			
N	TNB-28	Non boric oxide	Hard	BTT	Molybdenum	47			
K	KS-3	Lead boro-silicate	Hard	BSTT	Tungsten	36			
K	KK-1	Potash lead	Soft	SRT	Dumet	94 ± 2			
K	KL-1	Soda lime magnesia	Soft	BRT		100 ± 3			
H	*Mo-seal	Boro-silicate	Hard	BSTT	Molybdenum	49			
H	*Soft Stem	Potash lead	Soft	SRT	Dumet	94 ± 2			
H	*Soft Bulb	Soda lime magnesia	Soft	BRT		100 ± 3			

The power factor of these glasses have not been measured except TNB-28 which is as follows:

Frequency	10mc	600mc
tan δ · 10^{-4}	28	52

Notes

[1] Maker:
- S: Nihon Denki K.K. (Sumitomo Tsushin K.K.).
- N: Nihon Muson K.K.
- K: Kawanishi Machine Works.
- H: Hitachi Works.
- T: Tokyo Shibaura Electric Company.

[2] Number:
- * No number assigned.

[3] Main Use:
- BRT: Bulb for receiving tube.
- SRT: Stem for receiving tube.
- BTT: Bulb for transmitting tube.
- BSTT: Bulb and Stem for transmitting tube.
- BPHT: Bulb for phototube.
- SRCT: Stem for rectifer.

* Power Factor:

Temperature (°C):	20	100	200	300
tan δ x 10^{-4} for 10mc:	32	36	70	190

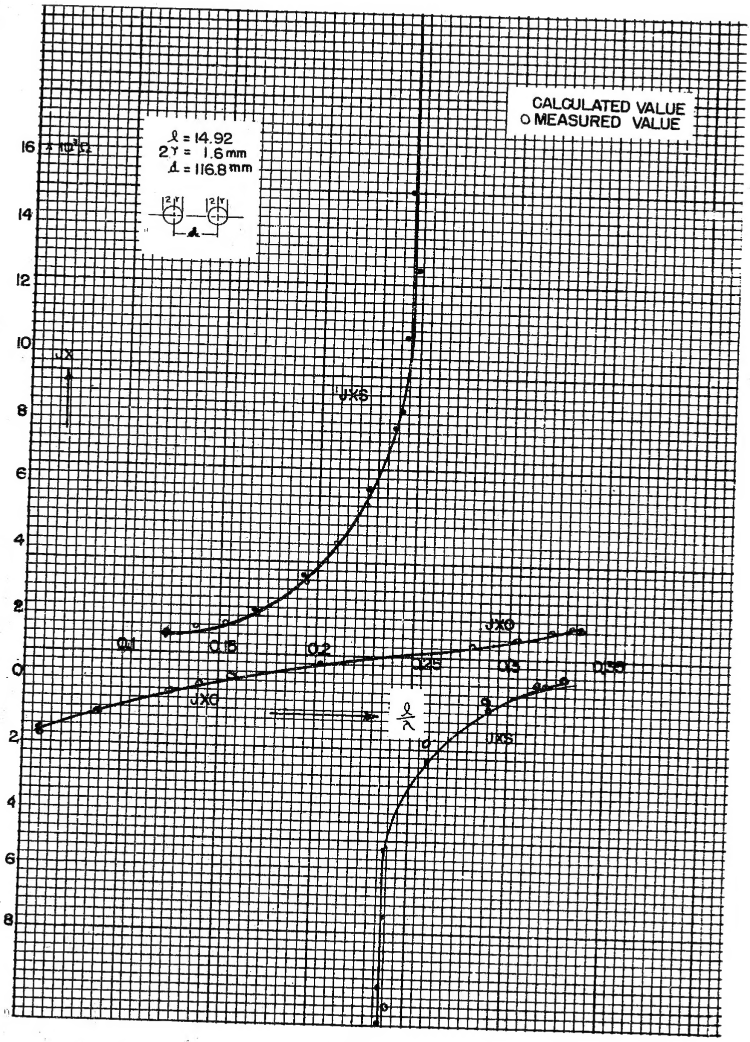


Figure 12

IMPEDANCE BRIDGE TEST MEASUREMENTS

ENCLOSURE (A)

LIST OF EQUIPMENT OBTAINED AT SECOND NAVAL TECHNICAL INSTITUTE, KANAZAWA, AND SHIPPED TO THE NAVAL RESEARCH LABORATORY

NavTechJap Equipment No.

JE21-6340 Experimental 19 Air Mark 4 (R-4) Transceiver.

JE21-6340.1	Dynamotor
JE21-6340.2	Transceiver
JE21-6340.3	Dynamotor-Transceiver Cable
JE21-6340.4	Control Unit.
JE21-6340.5	Modulator
JE21-6340.6	Loading Coil
JE21-6340.7	Microphone

JE21-6341
JE21-6342 Type 3 Air Mark 1 Model 3 (N-1) Transceiver.

JE21-6341.1 and 6342.1	Microphone
JE21-6341.2 and 6342.2	Keys
JE21-6341.3 and 6342.3	Dynamotor-Transceiver Cable
JE21-6341.4	Control Unit (1 only).
JE21-6341.5 and 6342.5	Transceiver

(Note: Dynamotor and calibration unit are the same as used with Experimental 19 Air Mark 1 Transceiver)

JE21-6343 Type 3 Air Mark 6 Model 3 Radar (H-6). Receiver.

JE21-6344 Dynamotor-Battery Test Cable.

JE21-6345 Experimental 19 (FP) Direction-Finder.

JE21-6345.1	Loop Antenna, for Small Plane
JE21-6345.2	Loop Antenna, for Large Plane
JE21-6345.3	Receiver
JE21-6345.4	Loop Rotating Mechanism

JE21-6346
JE21-6347 Experimental 19 Air Mark 3 Transceiver (R3) (12-Volt).

JE21-6346.1 and 6347.1	Dynamotors
JE21-6346.2 and 6347.2	Transceivers
JE21-6346.3 and 6347.3	Loading Coil Units
JE21-6346.4 and 6347.4	Dynamotor-Transceiver Cables
JE21-6346.5 and 6347.5	Transmitter-Coil Cables
JE21-6346.6 and 6347.6	Modulators
JE21-6346.7 and 6347.7	Microphones

JE21-6348 Experimental 19 Air Mark 3 Transceiver (R3) (24-Volt).

JE21-6348.1	Transceiver
JE21-6348.2	Loading Coil

JE21-6349 Experimental 19 Air Mark 1 Model 12 Radar (FK-3).

JE21-6349.1	Transmitter
JE21-6349.2	Dynamotor

ENCLOSURE (A), continued

NavTechJap Equipment No.		
	JE21-6349.3	Antenna Unit
	JE21-6349.4	Dynamotor-Transmitter Cable
	JE21-6349.5	Transmitter-Receiver Cable
	JE21-6349.6	Receiver-Remote Indicator Cable
	JE21-6349.7	Receiver
	JE21-6349.8	Remote Indicator
JE21-6350	Experimental 18 Air Mark 8 Model 2 (N-8) Radio Equipment	
	JE21-6350.1	Dynamotor
	JE21-6350.2	Transmitter
	JE21-6350.3	Experimental Receiver
	JE21-6350.4	Receiver
	JE21-6350.5	Earphones
JE21-6351	Experimental 18 Air Mark 8 Model 3 (N-8) Transceiver.	
	JE21-6351.1	Transceiver
	JE21-6351.2	Battery Boz
JE21-6352 JE21-6353	Experimental 19 Air Mark 1 (P-1) Transceiver.	
	JE21-6352.1 and 6353.1	Control Units
	JE21-6352.2 and 6353.2	Calibration Units
	JE21-6352.3 and 6353.3	Dynamotors
	JE21-6352.4 and 6353.4	Microphones
	JE21-6352.5 and 6353.5	Dyamotor-Transceiver Cables
	JE21-6352.6 and 6353.6	Transmitter-Control Unit Cables
	JE21-6352.7 and 6353.7	Transceivers
JE21-6354 JE21-6355 JE21-6360	Temporarily Designated Model 1 (FH-1) Altimeter.	
	JE21-6354.1, 6355.1, 6360.1	Transmitters
	JE21-6354.2, 6355.2, 6360.2	Receivers
	JE21-6354.3, 6355.3, 6360.3	Control Units
	JE21-6354.4, 6355.4, 6360.4	Indicators
	JE21-6354.5, 6355.5, 6360.5	Dynamotors
	JE21-6354.6, 6355.6, 6360.6	Antennae Units
JE21-6356	FM2A05A Transceiver Tubes.	
JE21-6357	FB325A Transmitter Tubes.	
JE21-6358	FZ064A Transmitter Tubes.	
JE21-6359	Crystals, Transmitting and Receiving (37).	